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Description of the Invention

Applicant's invention relates to a method for preparing membrane electrode assemblies (MEAs), and in particular to a method of manufacturing a proton-conducting cation-exchange electrolyte membrane for use in a membrane electrode assembly (MEA), in which atmospheric pressure plasma deposition is used to deposit catalysts such as platinum onto a polymer substrate, or a substrate including carbon cloth or carbon particles. The invention has two principal characteristics:

1) The noble metal catalyst is deposited on the membrane by discharge enhanced chemical vapor deposition (DECVD); and

2) The DECVD is carried out at atmospheric pressure, without adding noble gases to the DECVD carrier gas.

REMARKS

Claims 1, 3-9, and 11-16 are pending, and stand rejected.

Claim 1 has been amended. This amendment is supported by original disclosure on paragraph [0022] of the original disclosure. It is believed no new matter is added by this amendment.

Applicant notes that the arguments filed 10/3/2006 with respect to the rejections under 35 U.S.C. §103(a) have been considered, and the rejections under 35 U.S.C. §103(a) have been withdrawn.

The rejection based on the Fukuda reference have been considered, but have not been found persuasive.

Additionally, the Examiner is citing a new reference (US 6,010,798).

Response to the Examiner's Response to Applicant's Arguments:

Fukuda:

1. The Examiner points out that Applicant's invention requires that the reactants pass directly through the electrodes, while the Fukuda reference requires that the reactive gas is not directly in contact with the surface of either electrode. However, Applicant's claims were not commensurate in scope with this requirement. Applicant has now

amended calim 1 to require that the reactants pass "directly between 2 or more electrodes which create an electrical discharge...". It is believed that this amendment clearly distinguishes Applicant's claims from the Fukuda reference.

2. Applicant also maintains that that the Fukuda reference teaches away from Applicant's claims, since all claims teach the use of a noble gas, while Applicant specifically claims that the process occurs without adding a noble gas to the carrier gas. The fact that the Fukuda reference cites nitrogen as a useful inert gas, does not negate the fact that all of the examples of Fukuda are done using noble gases – directly opposite of Applicant's teaching.

35 U.S.C. §103

Hammerschmidt in view Fukuda

Claims 1, 3, 5-6, and 11-14, stand rejected under 35 U.S.C. 103(a) as being unpatentable over Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306). These references fail to create a *prima facie* case of obviousness over Applicant's claims as amended.

The Hammerschmidt reference describes a novel polymer electrolyte membrane arrangement. It offers little insight into the method for producing a proton-conducting cation-exchange electrolyte membrane, which is the subject of Applicant's invention. The Hammerschmidt reference describes only generally the process forchemical deposition as a "plasma-chemical process", using as examples chemical deposition at "low-pressure plasma between 10^{-4} and 10 mbar", and as an alternative "sputtering methods". (Col 3, lines 40 – 55). Both of these methods are very different from the atmospheric pressure plasma deposition method claimed by Applicant, and the differences have been clearly discussed in the many responses to rejections filed by Applicant in this application.

The Fukuda reference is discussed above. Applicant's claims as amended have distinguished over the Fukuda teaching of keeping the reactive gas away from the electrodes.

Neither the Hammerschmidt or Fukuda references, alone or together teach or suggest applicant's claims (as amended) of an atmospheric pressure plasma deposition method for forming a proton-conducting cation-exchange electrolyte membrane in which the carrier gas passes directly between the electrodes.

Hammerschmidt in view Fukuda and Schutze

Claim 4 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Hammerschmidt (US 6,010798) in view of Fukuda (US 6,849,306), further in view of Schutze. The Schutze The Schutze reference teaches a plasma jet using flowing helium. Applicant's amended claims cite a method without adding noble gases to the DECVD carrier gas. The Schutze reference not only fails to teach or suggest Applicant's claim limitation of no added noble gas, but teaches away from Applicant's claims by requiring a noble gas. The Schutze reference fails to correct the deficiencies of the other cited references, fails to teach or suggest Applicant's claim limitations, and teaches away from Applicant's claims.

Further in view of Yasumoto

Claim 7 stands rejected further in view of Yasumoto (US 2003/0096154). The Yasumoto is a secondary reference cited by the Examiner to teach the spraying of the catalyst onto the surface of the polymer electrode membrane. Applicant's do not claim a method in which a catalyst is sprayed onto a polymer electrode membrane, but rather a discharge enhanced chemical vapor deposition method. Thus the Yasumoto reference fails to teach Applicant's claims.

Further in view of Nanaumi

Claims 8-9 stand rejected under 35 U.S.C. 103(a) as being unpatebtable further in view of Nanaumi (US 2004/0180250).

The Nanaumi reference is cited to cite polymer electrolyte membrane structures. However the Nanaumi reference fails to teach or suggest Applicant's many claim limitations, and fails to correct the many deficiencies of the other references cited.

Further in view of Kamo

Claims 14 and 15 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6,800,336), and further in view of Kamo (US 2003/0059659). The Kamo reference is a secondary reference cited to show the use of a platinum alloy in the anode side of an electrolyte membrane. While the Kamo reference discloses a platinum/ruthenium alloy for a fuel cell electrode, the platinum/ruthenium alloy is supported on a carbon powder, rather than directly on a membrane as claimed by Applicant. In Example 2, the platinum/ruthenium alloy is screen printed using a slurry. One in the art would not be motivated by this method alone – or in combination with the other cited reference to practice all of the limitations in Applicant's amended claims.

Further in view of Haug

Claim 16 stands rejected under 35 U.S.C. 103(a) as being unpatentable over Dearnaley (US Patent Number 6,159,533) in view of Schutze in view of Fornsel (WO 01/32949, US 6,800,336), and further in view of Haug. The Haug reference is a secondary reference cited to show the deposition of multiple catalyst layers. The Haug reference demonstrates the use of a vacuum sputter deposition system for producing a PEM. The disclosure of a multiple layer of catalyst by methods teaching away from Applicant's claimed method fails to heal the defects of the cited art to present a *prima facie* case of obviousness.

Conclusion

The references cited, either alone or in combination, fail to teach or suggest all of Applicant's claim limitations, and therefore fail to present a *prima facie* case of obviousness over Applicant's amended claims. For the above reasons the present claims 1, 3-9, and 11-16 are believed by the Applicant to be novel and unobvious over the prior art, thus the claims herein should be allowable to the Applicant. Accordingly, reconsideration and allowance are requested.

Accordingly, reconsideration and allowance are requested.

Respectfully submitted,

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